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## The Ultimate Recyclable

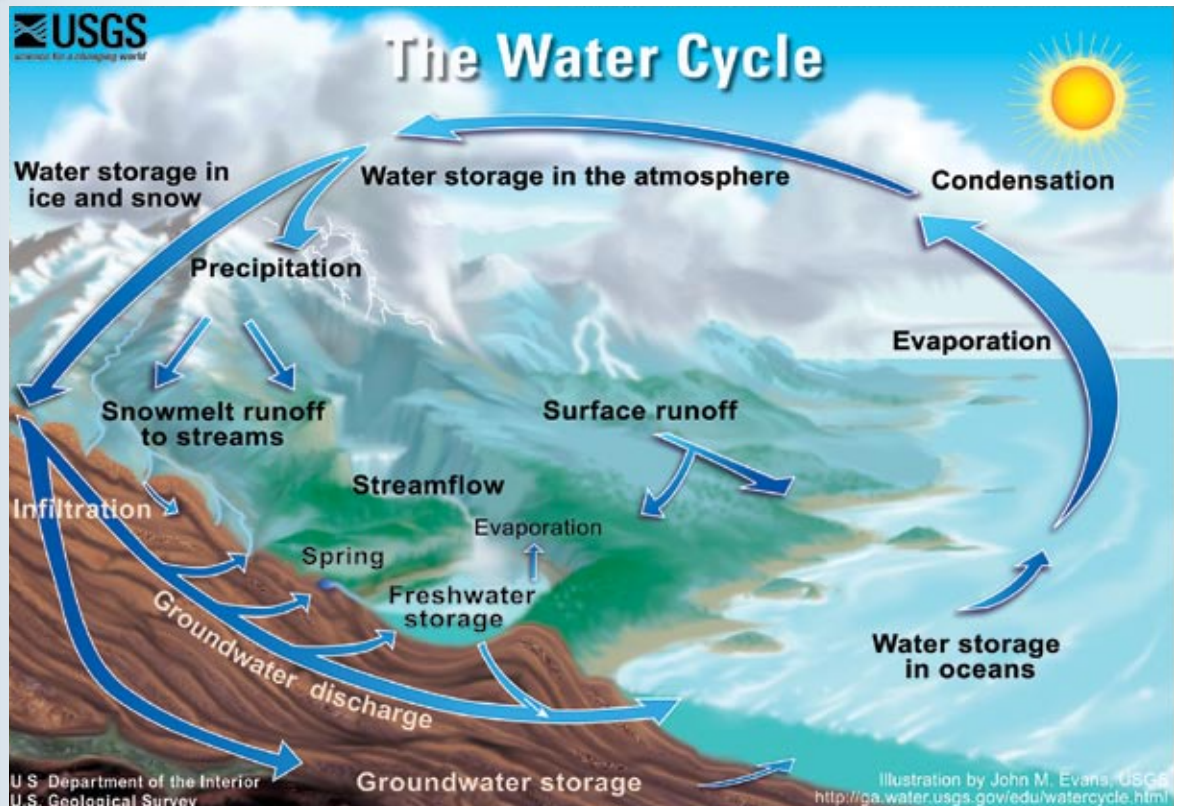


FIG. 2.1—Water is constantly recycled through the water cycle.

### Questions to consider

- ❶ What is the water cycle? Where does it start and where does it end? Where does water spend most of its time?
- ❷ What is weather? What is climate? How do they affect the quality and quantity of our water?
- ❸ What kind of climate does Missouri have?
- ❹ What is surface water? What is groundwater?
- ❺ Where does water go when it runs off a street?
- ❻ Where does our water come from? How does it get to our faucets?
- ❼ What happens to water after we've used it? Where does it go when it goes down the drain?

Pollution can make water unfit for people to drink. It also can make it harmful for plant and animals to live in it. Natural processes, however, can purify water over time. For three and a half billion years, the earth's water has been moving from streams to lakes to oceans, flowing underground, sitting high up on mountain glaciers, freezing and melting on the edges of the polar ice caps and forming clouds in the **atmosphere**. This never-ending round trip is called the **water cycle**, and it is the driving force behind weather and other natural processes. (FIG 2.1)

### Solar-powered water pump

The water cycle works like a huge water pump powered by solar energy and gravity. It is a global system, and every molecule of water on Earth travels through it. Because it is a cycle, it has no beginning or end—we can start at any point. The sun warms water on the Earth's surface and changes it into invisible water vapor. This process is called **evaporation**. Every time water evaporates, it leaves behind whatever salts, pollutants or other impurities were dissolved in it and becomes pure again. Living things—the **biosphere**—also return water to the atmosphere. Every time we exhale, we release water vapor. Photosynthesis causes plants to release water vapor into the air in the process of **transpiration**. A one-acre cornfield (about the size of a football field) can give off as much as 4,000 gallons of water every day.

Rising air takes the water vapor up into the atmosphere where it cools. Cooling water vapor condenses as fog, mist or clouds. Raindrops and snowflakes condense around microscopic dust particles suspended in the atmosphere. Water can pick up other contaminants from the air, too, such as smog (forming **acid rain**) or mercury vapor from trash incinerators and coal-burning power plants. Water returns to Earth as precipitation, either liquid (rain) or solid (snow, sleet or hail). It also can condense on ground-level surfaces as dew or frost. About 85 percent of the world's precipitation falls into the oceans. The rest falls on land.

## Talk about the weather

The amount of water that falls in a local area changes with each season. Weather also increases or decreases the amount of available water. Seasonal weather patterns move water around the world and from the atmosphere back to the Earth's surface. In fact, weather is the name we give to the movement of water through the water cycle. Average weather conditions over longer times are what we call climate. How much water a certain region will have in a given part of the water cycle depends on:

- the amount of rainfall
- the effect of temperature on evaporation
- the amount of water plants use during the growing season.

Even small changes in the global cycle can cause droughts or floods at the local level.

Missouri tends to have hot, humid summers and cold, damp winters. Some parts of Missouri receive abundant rain in late spring and may experience flooding. Other places may receive sparse rain in mid-summer and experience drought. Throughout Missouri, plants have plenty of time to grow each year. But every part of Missouri can expect to experience below-freezing temperatures each winter. We can't control the weather, but we do influence it. What we do or don't do to the atmosphere (keep the air clean or dirty), the biosphere (conserve or squander forests and prairies) and the geosphere (conserve soil or let it wash away) affects the quality of water and its movement through the water cycle (the hydrosphere).

## Surface water runs off

On land, plants catch most rainfall before it reaches the Earth's surface. In a forest, for example, rain slowly drips off leaves and trickles down branches. Roots and the leaf-covered forest floor act like a sponge, soaking up water and slowly releasing it into waterways. About 66 percent of the 4,200,000,000 gallons of precipitation that

fall on the continental United States each year returns to the atmosphere right away. Half of the rest runs off the surface of the land. This water is called **surface water**. It may collect in streams and flow to the ocean. Or people or other animals may slow or stop its flow to form ponds or lakes. When **precipitation** falls as snow, it can build up as snowpack, ice caps and glaciers. Ice caps and glaciers can store frozen water for thousands of years. Snowpacks in warmer places often thaw and melt when spring arrives. The melted water flows overland as snowmelt.



FIG. 2.2—Instead of soaking into the ground, stormwater runs rapidly over paved surfaces, taking pollution with it into our lakes, rivers and wetlands.



FIG. 2.3—Storm drain stenciling reminds us to protect our waterways.



If rain is hitting the ground faster than it can soak in, it becomes **runoff**. The slope of the ground also affects runoff. On steep slopes, water moves quickly and very little of it soaks in the ground. Hard surfaces reduce the amount of water that soaks into the soil even further. Paved roads, rooftops and parking lots block water from soaking in, so all of it becomes runoff. (FIG. 2.2) Heavy rains run off streets, sidewalks and other paved surfaces up to 10 times faster than on unpaved land. The faster water flows, the more power it has to wash away soil or to cause flash flooding. Stormwater that runs off paved roads, rooftops and parking lots flows into ditches and storm drains. This water then drains directly into streams, lakes and **wetlands** without any filtration or treatment. (FIG. 2.3) Any excess fertilizer, pesticides, mud, motor oil and antifreeze, trash, even lawn clippings and pet waste on the pavement wash into waterways during heavy rains. (FIG. 2.4)

## Let it soak in — groundwater

Plants, animals and people use some of the rain that falls on land. The rest of the rain—only about 3 percent—soaks into the ground. When water soaks into the ground it fills the empty spaces between soil particles. The water may remain as soil moisture, evaporate back into the atmosphere, be taken up into the roots of plants or trickle slowly through the soil. The solid part of the Earth is called the **geosphere**. Below the Earth's surface, layers of spongy soil, sand and rock act as filters to help clean the water. But if the water is badly polluted, the soil can't remove all of the pollutants. In some cases, water moving through the geosphere can even pick up pollutants already present in the soil. Eventually the water reaches a layer where all the spaces in the soil or rock are already filled up. This area is called the **saturated zone**, and the water it holds—over half of



FIG. 2.4

the fresh water on Earth—is called **groundwater**. (FIG. 2.5) The boundary between the spongy layer and the saturated zone is known as the water table. The water table rises or falls as the amount of groundwater in the saturated zone increases or decreases.

Areas of underground rock that hold water in pores or crevices are called **aquifers**. To use the water in aquifers, people dig wells to bring it to the surface. Unfortunately, digging a well and pumping out groundwater can lower the water table and can cause lakes, streams and wetlands to dry up. Sometimes the Earth's surface can sink or even collapse when we pump out too much groundwater. In most places,

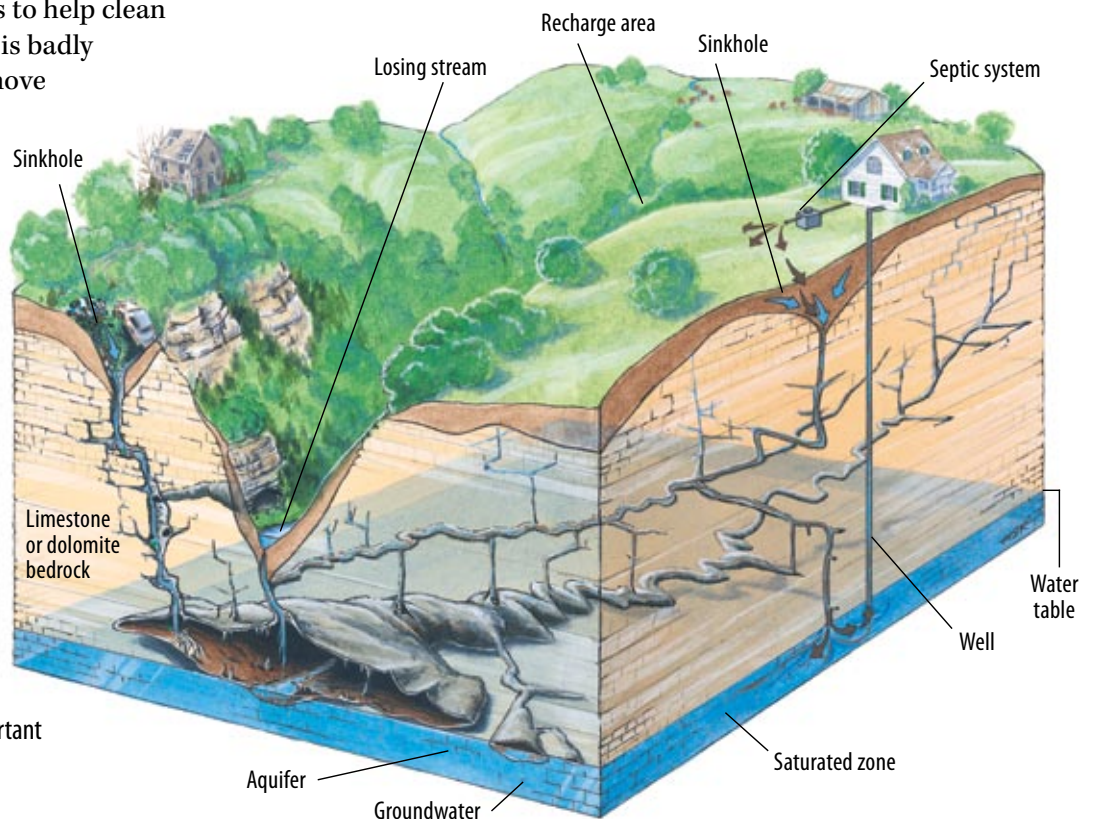


FIG. 2.5—Groundwater is an important source of drinking water that is not readily renewed by the water cycle.

groundwater moves so slowly that aquifers can take thousands of years to fill back up. In the Ozarks, however, the rate of flow is much faster and can be measured in miles per hour. Places where water soaks into aquifers are called **recharge** areas. Some streams lose water to the soil or rock around them. They are called losing streams. Streams that receive groundwater are called gaining streams because they gain water from the soil or rock around them. Where groundwater appears on the surface it forms springs.

## Water coming and going

Missourians depend on both surface water and groundwater sources for drinking and other uses. In general, people in the northern half of the state (north of the Missouri River) as well as metropolitan Kansas City and St. Louis use surface water. In fact, the Missouri River itself is the source of tap water for over 2 million people—more than a third of the state's population—including metropolitan Kansas City and St. Louis. Most rural Missourians get their tap water from groundwater wells. Some well water is safe to drink right out of the ground. In other cases, it must be treated first. For community water supplies, water from



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## After the flush

Wastewater treatment plant workers process wastewater so it is safe to return to the environment. They run equipment that removes or destroys chemicals, bacteria or other harmful pollutants in the water. They also control pumps and valves that move wastewater through the treatment processes. Wastewater treatment plant workers inspect sewage treatment systems and investigate sources of pollution to protect the public and environment. These jobs, like those of drinking water treatment workers, require special certification from the state.

## Drinking water treatment plant workers make water safe to drink

Plant workers read and adjust meters and gauges to make sure the plant equipment is working right. Water from wells or surface water intakes is piped to the treatment plant, where workers may add chemicals to the water to treat it. They take samples of the water and analyze them in the lab. Water treatment plant workers must be licensed by their states. Workers must pass tests and prove work experience before they get a license to treat water for the public to drink.



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wells or surface water intakes is piped to a drinking water treatment plant. There workers may filter the water or let it settle to remove suspended material. They also may add chemicals to the water to kill bacteria and other organisms. Pipes buried in the ground carry the water to homes and businesses.

A different set of underground pipes carry used water (sewage) to wastewater treatment plants. In rural areas sewage lagoons receive wastewater, letting it evaporate slowly. Underground septic systems store wastewater until it can soak into the ground. All of these methods include a step in which bacteria break down organic matter, helping to make the wastewater safer to return to the environment. Water from sewage treatment plants is piped back into surface waters such as rivers, lakes and wetlands after it is treated.